

# AN ANALYSIS OF THE SPONTANEOUS RESPONSES OF THE NEWBORN INFANT\*<sup>1</sup>

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## INTRODUCTION

A survey of the literature regarding the behavior of the newborn infant (6) reveals that although there have been many studies seldom have these reports contained descriptions which would make it possible to compare the responses of the newborn with those of other subjects. The responses have been named but not described. In the absence of such description some writers have gone so far as to doubt whether the responses of the newborn are in any sense organized or patterned. The present study is connected with a detailed analysis of the spontaneous responses of the newborn, defining spontaneous responses as those responses which occur without stimulation by the experimenter.

The study is divided into two parts. In the first part a set of cinematographic data were analyzed and a tentative classification and analysis of the responses arrived at. It was not practicable, however, to obtain a large quantity of moving-picture records. Consequently, in the second part the tentative analysis was checked against a large number of direct observations in order to test its general applicability.

## SURVEY OF THE LITERATURE

As stated above, a search into the literature reveals little actual description of the spontaneous responses of normal newborn infants. This brief review includes all the descriptions found.

*Yawning.* Blanton (1) witnessed one subject yawning at five

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hours, with eyes tightly closed. Another subject's eyes were squeezed tight, and her chin trembled as she shut her mouth. Still another yawned so slightly that the yawn was hard to distinguish from a sigh.

*Crying.* Blanton (1) reports that the subject in crying pulls down the inner corners of the brows, making wrinkles. The square, box-shaped mouth is noted also. Preyer (12) notes drawing down of the corners of the mouth and wrinkling of the forehead. Irwin (9) states that kicking occurs during crying. Irwin and Weiss (11) regard crying as a component of mass activity.

*Sneezing.* Champneys (3) says: "Sneezing was always accompanied by violent movement of all the limbs, the thighs being flexed on the abdomen, the forearms bent, and the elbows thrust forward."

*Sucking.* Escherich (8) says that sucking consists chiefly of a downward movement of the lower jaw, with the tongue movement secondary to this. Blanton (1) describes sucking as consisting of the tongue protruding from the mouth with the edges curled upward and over in such a way as to make the partial vacuum essential to sucking.

*Stretching.* Bühler (2) says that in stretching the head is bent dorsally, hands are extended above the head, and the legs are extended. Blanton (1) has described stretching as a movement varying from a mere full raising of the arms and a complete stretching of the legs and toes, to arching of the back and abdomen and pushing of the arms until they tremble, accompanied by the bending of the ends of the fingers. In one case she notes a movement of the neck and pulling forward of the shoulders.

## PART I

*Subjects.* Four white subjects were used in this experiment, ranging in age from the first day through the tenth day. All the infants were born in the University Hospital and, according to hospital charts, all subjects were normal and in good health. Additional data on each subject are as follows:

Toms, female, birth wt. 4000 gms., third child of 23-year-old mother. Studied from fifth through ninth day.

Welcher, male, birth wt. 3260 gms., third child of 27-year-old mother. Studied from seventh through ninth day.

Dameron, female, birth wt. 3500 gms., third child of 36-year-old mother. Studied from first through tenth day.

Street, female, birth wt. 2725 gms., first child of 18-year-old mother. Studied from first through eighth day.

*Method of Securing Records.* The infants were studied in the nursery of the University Hospital. They were photographed in their steel cribs (approximately 14" x 28" x 10") which were fastened to the wall so that the tops of them were 4 feet from the floor. Upon the crib was placed the four legs of a specially constructed wooden camera holder. This put the Cine Kodak Camera (Model B. K. A., f 1.9 lens, 100-ft. film capacity, 16 exposures per sec.) in a position 5 feet above the baby.

Floodlighting was obtained by the use of a double Kodalite (Model B, containing two 500-w., 115-v. Mazda lamps) which was thrown against the wall directly above the crib. It was found in the preliminary photographing that to insure uniform running and timing of the camera it was necessary to remove the camera from the holder and rewind after approximately 30 seconds of running. Timing was done by means of a stop-watch.

All pictures were taken between eight and nine o'clock in the morning, immediately after bathing and before feeding at 9:15 A.M.

Two infants were available for study each morning, and they were photographed alternately. One experimenter (Dr. Dennis) operated the camera and one (Gilmer) recorded the name of the baby, its condition, and the nature of the reaction. An attempt was made to photograph all the spontaneous movements of the infant which was under the camera. *The camera was started at the beginning of each response*, unless the camera-man was obviously too late, and was not stopped until the response had ended. Sixteen hundred feet of Cine-Kodak Panchromatic Safety film were used.

*Method of Analysis.* The apparatus used in studying the film was a hand-cranked Vitascope Movie Maker (burning a 100-w., 115-v. Mazda projection lamp). Pictures were projected against a white wall. The projector was so arranged that the pictures could be run backward as well as forward. Speed of movement could be made to vary from around 32 exposures per sec. to a stilling of the individual frames.

After a great deal of preliminary study of the records we felt that we had arrived at an adequate classification. Each response was numbered and named. Then, by repeated showing of each response, the constituent elements were determined and the basis of classification was thus arrived at. After this analysis had been made,

the experimenter reclassified and reanalyzed several responses without knowledge of the reel and picture presented (pictures selected by Dr. Dennis). A confirmation of the original classification and analysis was made in all cases.

*Definition of Descriptive Terms Used.* The results of the cinema analysis are presented in Table 1. Before discussing this it is necessary to define some of the terms used. Only those terms which are not commonly employed will be defined.

*Corners of the mouth retracted.* Here we have the corners pulled towards the ears.

*Mouth horizontal.* In this paper the ear-to-ear direction will be called horizontal and the forehead to chin direction will be called vertical. We use the term "mouth horizontal" to describe a mouth opening in which the corners are retracted, that is, separated farther than in their resting position.

*Mouth vertical.* Here we find the corners are not retracted but that the movement consists wholly in vertical opening. The degree of opening is variable.

*Tongue "flat" and protruding.* The tongue comes forward in varying degrees, flat from side to side although sometimes arched in the dorso-ventral direction.

*Tongue "trough" and protruding.* In this position the tongue is the same as above save that the outer edges of the tongue are turned upward and over, forming a rounded trough.

*Naso-labial fold.* Term used in describing the lines running from the corners of the nose to the corners of the mouth.

*Naso-labial fold extending to the chin.* Here the line extends beyond the corners of the mouth to a distance of approximately half way down the chin.

*Wrinkled at the bridge of the nose.* Here we have a line across the nose connecting the inner corners of the two eyes.

*Shortened nose.* The end of the nose is pulled upward toward the forehead.

*Chin drawn in to neck.* The head is pulled slightly downward until the chin rests lightly against the neck. This is always accompanied by the skin on the chin being wrinkled in furrowed horizontal lines or in the "dried peach" shape.

*Results.* It was found possible to classify the responses into distinct classes. Each of these classes was then analyzed in detail to discover its elements. The results of this analysis are given in Table

1. In compiling this table two or more identical reactions (such as cries) which occurred without intervening reactions were treated as one unit in the tabulation. This latter procedure was adopted as a conservative measure because such consistency of response pattern in temporally contiguous responses might misrepresent the consistency of the responses in general.

It was found in the analysis that the data from each individual subject were so well in agreement with the data of each other subject that the responses could be grouped. The total number of units represented in Table 1 are as follows: 34 cries, 25 mouthings, 23 stretches, 22 yawns, 20 openings of the mouth, 12 chewings, 10 suckings, 8 smiles, and 7 sneezes; total, 161. Other responses not included in the table will be discussed later.

Table 1 shows in brief the comparative analyses of these reactions. Each type of response is listed at the top of the table, with the exception of those few responses to be discussed later. The percentage of occurrence of each response element is given in the table. Study of the table will show in regard to each type of response which elements were essential (always present), which were incompatible (never present), which were unessential (sometimes present), and which were peculiar to that reaction (never present as an element of another reaction).

We shall summarize briefly our findings in regard to each response. The summaries below include the data of Table 1 and also additional data which could not readily be presented in the table.

#### *Tentative Analysis of the Reactions*

*Crying.* In crying, the mouth is always opened in some horizontal fashion ranging from slightly horizontal through the extreme horizontal position in which the mouth takes on the four-cornered box-shape. The naso-labial fold is always present. At the beginning of any crying period the eyes may be in an open, half-open, or a normally closed position. The eyes are, however, always closed tightly by the time the height of the cry is reached. (The observational study of Part II shows that this is an incorrect generalization.) When the eyes are tightly closed wrinkles are always found under them, together with a pulling down of the nasal end of the brow. In crying, we find present in every instance the line connecting the inner corners of the eyes across the bridge of the nose. We find also that the chin is always pulled toward the neck enough to produce the furrowed wrinkles, although in varying degrees.

TABLE 1  
PERCENTAGE OF TOTAL RESPONSES OF EACH TYPE CONTAINING RESPONSE  
ELEMENT

	Crying	Stretching	Sneezing	Mouthing	Yawning	Opening mouth	Chewing	Sucking	Smiling
Asleep	6	96	43		32			30	100
Awake and quiet	56	4	43	100	68	100	100	70	
Awake and restless	34		14						
Corners of mouth retracted									
Mouth closed		100	30					100	100
Mouth horizontal	100		14				8		100
Mouth vertical			72	100		100	92		
Lips rounded and protruded			14		100			100	
Tongue "flat" and protruding									
Tongue "trough" and protruding				88					
Eyes open				12				100	
Eyes half open				8		20			
Eyes closed normally				72		45		80	
Eyes closed tightly	100	9		20	9	35	42	20	100
Naso-labial fold	100	91	100		91		58		
Naso-labial fold ext. to chin		91	70		100	10	100		
Wrinkled at bridge of nose	100		30						100
Shortened nose					100				

TABLE 1 (*continued*)

	Crying	Stretching	Sneezing	Mouthing	Yawning	Opening mouth	Chewing	Sucking	Smiling
Chin drawn in to neck	100					5	100	100	100
One or both arms relaxed				68	73	65	92	90	100
One or both arms tense	23				27				
One or both arms moved up or down	68			8		20	8		
One or both arms moved in or out				24		15		10	
One or both arms extended above the head	9	9							
Forearms drawn toward head and shoulders		91							
Forearms jerked slightly up and in toward head			100						
One or both legs relaxed				68	82	65	92	100	100
One or both legs tense	15				18				
One or both legs extended				20		15	8		
One or both legs flexed	17	100	100	12		20			
One or both legs kicking	68								

Limb movement is not always present, but when it is the movements of the hands and feet are in a plane parallel to the median plane of the body. The amount of limb movement varies with the intensity of the cry. Every intense cry produces much arm and leg movement. In this degree the arms are worked rapidly up and down while the legs are kicking violently. When the arms and legs are not moved in crying they are always held tense. Although not shown by the table, the analysis shows that crying has a slow termination as opposed to a rapid ending found in some other reactions.

What may be termed a "cry face" was noticed several times but not put into the table. Here we have all the facial features of a cry save that the mouth is not opened. The corners of the mouth are drawn slightly inward and downward. Limb movement is practically nil. This "cry face" appears to be the slightest degree of crying.

Only in crying do we find the mouth in a four-cornered box-shape, and the face wrinkled at the bridge of the nose. These elements never occur in isolation nor in any other spontaneous reactions save crying.

*Stretching.* In stretching we find the mouth always closed, and in the majority of cases the eyes are closed tightly. The naso-labial fold is found present only in those cases in which the eyes are closed tightly. In the larger number of cases the forearms are drawn in toward the head and shoulders with the upward pull being at the shoulders rather than in the forearms. In the remaining cases the arms are straightened out above the head. These responses are peculiar to stretching. Contrary to Bühler's statement, the legs are always flexed. (Dr. Dennis reports that he saw leg extension in stretching in one of four premature infants studied by him.) In a number of cases we find the subject rearing up on the back of the head and arching the back. This seems to occur in the more extreme stretches. The termination of a stretch is somewhat drawn out. Stretching always occurs in a sleeping or quiet and awake state, never breaking in upon a cry.

*Sneezing.* In the sneeze we do not find any stereotyped opening of the mouth; it may close or it may open horizontally. The eyes are always closed tightly on the inspiration and remain so until the expiration. The naso-labial fold is present in each case and extends to the chin in some of them.

In strong sneezes, the forearms are jerked slightly upward and



inward and the legs are flexed in each instance at the moment of expiration. Slight sneezes are observed in which there are no arm and leg movements, but there are never movements of any other kind than those just described. These movements are peculiar to sneezing. The sneeze terminates immediately after expiration.

*Mouthing.* The feature that distinguishes "mouthing" from "opening the mouth" is the protrusion of the tongue from the mouth against or across the lower lip. The mouth is always open in a horizontal position although in varying degrees. Degree of opening the eyes varies. In two cases it was noted that one eye remained half open while the other one closed lightly. In the majority of the cases the limbs are relaxed, never are they held tense. In those cases in which arm or leg movement is reported we find this movement to be very slight and apparently of little force. In every case of mouthing, the infant is awake and relatively quiet.

*Yawning.* Yawning is the only reaction in which we find a vertical opening of the mouth. The naso-labial fold is always present and approaches a vertical position. The nose is always shortened. There is practically no movement with the arms and legs, the subject in most cases being relaxed. In general, it can be said that the yawn terminates immediately after its peak is reached. Yawns occur while the subject is either in a sleeping or awake and quiet state.

*Opening mouth.* This response differs from the yawn in that in this case the mouth never opens vertically (this is obviously not true of older children). The mouth may open horizontally in varying degrees. The naso-labial fold is present when the mouth is opened widely. In some cases the eyes are closed normally and in the others opened to different degrees.

Where limb movement does not occur the limbs are always in a relaxed posture rather than tense. When the extremities do move they may go in any direction but with very little force, these movements are not recorded on the chart. The reaction always starts when the baby is in an awake and quiet state.

*Chewing.* Chewing is distinguished from the other mouth reactions by an up-and-down movement of the lower jaw, with no accompanying tongue play or lip reaction as found in sucking. The mouth is opened horizontally in varying degrees in 11 of the cases. In the other case the mouth is entirely closed. The eyes are always closed though sometimes normally and sometimes tightly. Both the naso-labial fold and the drawn chin are present in each instance.

*Sucking.* The essential features in spontaneous sucking are the tongue protruding beyond the lips in the "trough" shape, and the rhythmic motion of the lower jaw. The corners of the mouth are always retracted as the lips become rounded and protruded. The naso-labial fold is always present. The chin is always drawn in to the neck and in one case forms wrinkles in the "dried peach" shape, in the others forms the furrowed lines. The eyes are either half open or closed normally. The limbs are usually in a relaxed state. Only in one case do we find slight movement.

*Smiling.* The essential and peculiar factor in the smile is the retraction of the corners of the mouth, together with an upward pull of the corners. We find each of the eight cases recorded perfectly stereotyped in that the corners of the mouth are always retracted, mouth closed, eyes closed normally, naso-labial fold extended to the chin, chin drawn in to neck, all limbs relaxed, and occurring in the sleeping state. (The observational study shows that the infant may be awake and the mouth open during a smile.)

*Other reactions.* In addition to the above patterned or organized reactions, we find certain isolated limb movements. The movement of an arm or leg may be in any possible direction, but it is to be noted that such a movement is never as vigorous as those movements wherein the total organism is brought into play. Rubbing the face was noted frequently. Vomiting and hiccoughing were observed. Frowning, and wrinkling of the forehead in horizontal furrows, were observed to occur. Because of their relative simplicity these reactions were not added to an already-cumbersome table.

These above reactions recorded in this section are *all* the responses observed, both those occurring in large patterns, and those occurring in relative isolation. By no means has the above classification been "selective." All behavior which occurred has been included.

## PART II

The cinematographic study resulted in tentative descriptions which could not be entirely relied upon because of the small number of responses which were studied. While we did not believe that newborn responses could be completely analyzed as they occur in the nursery, we did believe that any common deviation from the descriptions arrived at above would be obvious upon protracted direct observation. Consequently, we observed a large number of sponta-

neous responses as they occurred in the nursery and noted whether each, in so far as it could be observed, did or did not conform to the tentative description. Observations were made between 8 and 9 A.M. as in Part I. A total of 16 babies were observed.

All infants studied were normal white babies under ten days of age. The responses were classified as follows: 185 cries, 120 stretches, 44 sneezes, 120 mouthings, 80 yawns, 85 openings of the mouth, 60 chewings, 60 suckings, and 45 smiles. Since detailed analysis of rubbing the face, vomiting, and other reactions were not made in the study of Part I, they are not tabulated here. However, each such response was critically observed for elements believed to be peculiar to the analyzed responses. We saw no new responses, and none which could not be fitted into the classification earlier arrived at.

The results of the observational study may be put very briefly. The observational data conflicted with the earlier data on only two points. These have been mentioned parenthetically in the tentative descriptions but will be repeated here:

1. *Crying*: In crying the eyes are not always closed. In addition the chin was seen to quiver in a few instances.
2. *Smiling*: Seven smiles were seen in which the mouth was slightly open. These occurred while the infant was awake and quiet.

The direct observations thus provided almost complete corroboration of the movie analysis.

#### SUMMARY AND DISCUSSION

This study has shown that it is possible to separate the unselected spontaneous responses of the newborn infant into distinct classes. This in itself seems to show that the responses show organization. Further analysis has revealed the detailed characteristics of each class of response. The descriptions arrived at by this analysis are too long to be repeated here, but reference to them will show that each response has a characteristic combination of essential elements and nearly every response has some element peculiar to it. Of the non-essential behavior elements, some do and some do not appear in conjunction with each response. If "pattern" and "organization" mean anything, they mean just those things outlined above.

It is interesting to note further that spontaneous responses of the newborn may be divided into two groups with respect to the rôle of the limbs in the responses. Reference to the behavior descriptions

will show that in intense crying, sneezing, and stretching, the legs and arms are vigorously involved, the mode of involvement being peculiar to each response. In the case of the facial responses, on the other hand, the limbs are never vigorously involved. The legs and arms are either totally inactive at the moment of facial response or else they are moving with slight force as in isolated limb movements. Limb stretching, for instance, never occurs during mouthing, although there is no anatomical impossibility in this. These facts mean, in brief, that the newborn's behavior organization is body-wide, his responses are total bodily responses. The body segments do not act in complete isolation. This is an interesting fact in connection with Coghill's theories (4, 5), in connection with Irwin's application of them to infants (9, 10), and in connection with Dennis' criticism of Irwin's application (7). Our study supports Dennis' claim that mass activity is not the only total bodily response of infants, but that, on the contrary, there are many total bodily responses.

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## UNE ANALYSE DES RÉPONSES SPONTANÉES DU NOUVEAU-NÉ

(Résumé)

Cette étude nous donne une analyse de toutes les réponses spontanées du nouveau-né. L'expérience se divise en deux parties. Dans la première partie on trouve les données obtenues d'une étude cinématographique. De ces données on arrive à une classification et à une analyse expérimentales. Pour tester la valeur de l'application de cette analyse expérimentale on se sert d'une deuxième méthode, celle de faire des observations directes. Les données obtenues par les deux méthodes différentes s'accordent en presque tous les détails. On a employé un nombre total de vingt sujets, âgés d'un jour à dix jours. On a étudié ces enfants dans la chambre des enfants de l'Hôpital de l'Université. L'analyse classe les réactions ainsi: celle de pleurer, celle de s'étendre, celle d'éternuer, celle de mouvoir la bouche, celle de bâiller, celle d'ouvrir la bouche, celle de mâcher, celle de sucer, et celle de sourire. On analyse chacune de ces réactions en détail. La Table I montre brièvement les analyses comparatives de ces réactions avec les éléments des réponses et le pourcentage des fois où ils se voient. Cette étude a montré le fait qu'il est possible de séparer en classes distinctes les réponses spontanées non choisies du nouveau-né. Chaque réponse montre une combinaison caractéristique d'éléments essentiels et presque toutes les réponses ont un élément propre. L'organisation du comportement du nouveau-né est de tout son corps, ses réponses sont des réponses totales du corps. Ce fait est très intéressant à propos des théories de Coghill. Cette étude soutient l'assertion que l'activité globale n'est pas la seule réponse totale du corps chez les nouveau-nés, mais qu'au contraire il existe plusieurs réponses totales du corps.

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## EINE ANALYSE DER SPONTANEN REAKTIONEN DES NEUGEBORENEN SÄUGLINGS

(Referat)

Diese Untersuchung bietet uns eine Analyse aller spontanen Reaktionen des neugeborenen Säuglings. Die Untersuchung ist in zwei Teile getrennt worden. Im ersten Teile haben wir die aus einer kinematographischen Untersuchung erhaltenen Befunde. Auf Basis dieser Befunde gelangen wir zu einer vorläufigen Klassifizierung und Analyse. Um die allgemeine Anwendbarkeit dieser vorläufigen Analyse zu prüfen hat man eine zweite Methode—die Methode der direkten Beobachtungen—angewendet. Die mit den zwei verschiedenen Methoden erhaltenen Befunde stimmen in fast jeder Einzelheit mit einander überein. Es dienten im Ganzen 20 Versuchspersonen, deren Alter sich zwischen einem Tag und 10 Tagen erstreckte. Die Säuglinge wurden in der Kinderstube des University Hospital untersucht. Durch die Analyse wurden die Reaktionen folgenderweise klassifiziert: Schreien, Sich-Strecken, Niessen, Gesichterschneiden [mouthing], Gähnen, Mundöffnen, Kauen, Saugen, und Lächeln. Jede dieser Reaktionen wird ausführlich analysiert. Auf Tabelle I sieht man, kurz dargestellt, die vergleichenden Analysen dieser Reaktionen, samt den Bestandteilen der Reagierungen und dem Prozentsatz ihrer Häufigkeit. In dieser Untersuchung ist erwiesen worden, dass es möglich ist, die unausgelesenen, spon-

tanen Reaktionen des neugeborenen Säuglings in einzelne Klassen zu teilen. Bei jeder Reaktion findet man eine charakteristische Verbindung wesentlicher Elemente, und fast jede Reaktionsweise hat einen Bestandteil, der ihr eigen ist. Die Organisation der Tätigkeit des Neugeborenen erstreckt sich über den ganzen Körper [is body-wide]; seine Reaktionen sind Gesamtreaktionen des ganzen Körpers. Diese Tatsache ist in Bezug auf Coghill's Theorien von Interesse. Durch diese Untersuchung wird die Behauptung unterstützt, dass Massentätigkeit nicht die einzige körperliche Gesamtreaktion [total bodily response] bei Säuglingen ausmacht, sondern dass es im Gegenteil viele körperliche Gesamtreaktionen gibt.

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